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Another series of tables is to be constructed to facilitate the introduction of corrections for refraction and other corrections which are troublesome in reducing measures made on plates covering large areas of the sky.

The formulæ taken as the basis of these tables are those given by Professor TURNER, but the refraction-table will give all of the differential refraction so that the four-constant solution for the plate constants which is recommended by Professor JACOBY may be employed if desired.

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## NOTE ON A CORRECTION TO THE SECOND EDITION OF SCHÖNFELD AND KREUGER'S "ATLAS DES NÖRDLICHEN GESTIRNTEN HIMMELS."

Upon comparing two photographic plates taken at the Students' Observatory the night of 1905, March 7, with this map, a star of about 8.5 magnitude contained upon the map in $\alpha = 11^h\ 14^m.1$ and $\delta = +11^\circ\ 25'$ was found missing on the plates. Reference was then made to the Durchmusterung positions, and no star was found having these coordinates, showing the Atlas position to be an error.

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## THE VARIABLE RADIAL VELOCITY OF *SIRIUS*, AND THE INCLINATION OF ITS ORBIT-PLANE.

The determination of a double-star orbit from micrometer observations of the primary star and its companion leaves an ambiguity as to the inclination of the orbit-plane to the line of sight. There are two positions of the orbit-plane which satisfy the observations equally well. At any given instant the companion may lie beyond the primary or at an equal distance this side of the primary. The orbital motion of the companion may be carrying it either further from the observer or nearer to him. The observations do not permit us to decide which of the two positions is the correct one.

If the two stars are also observable accurately by means of a spectrograph for motion in the line of sight, a comparison of their speeds toward or from the observer will remove the ambiguity in the value of the inclination of the orbit-plane. If only one of the stars is observable spectrographically, the removal of the ambiguity requires that the observations be continued long enough to decide as to whether it is the orbital motion to or from the observer that is accelerating.

The parallax and the elements[1] of the orbits of the binary star *Sirius* are probably more accurately determined than in the case of any other double star, with the possible exception of *α Centauri*. ZWIERS's elements on the above system are:[2]

$P = 48.8421$ years
$T = 1894.0900$
$a = 7''.594$
$e = 0.5875$
$\Omega = 44^\circ\ 30'.2$ (1900.0)
$\omega = 147\ 53.6$, position angles decreasing
$i = \pm 46\ 01.9$
$\mu = 7^\circ.37069$

The weighted mean value of the Cape of Good Hope determinations of the parallax is 0″.37.[3] AUWERS's result[4] for the relative masses of *Sirius* and its companion is 2.20:1.04.

LEHMANN-FILHÉS[5] has developed a very convenient formula for determining the radial velocity of a star due to its orbital motion.

If we let the radial velocity $V$ be expressed in kilometers per second, $a$ in seconds of arc, $P$ in mean solar years, $\pi''$ the star's parallax in seconds of arc, 149,500,000 the mean distance of the Sun in kilometers corresponding to a solar parallax of 8″.80, and let $v$ represent the true anomaly at the instant for which $V$ is desired, then

$$V = \frac{149,500,000\, a\, 2\, \pi \sin i}{365.25 \cdot 86,400\, \pi''\, P \sqrt{1 - e^2}} [e \cos \omega + \cos (v + \omega)],$$

or $$V = [1.{}^{6}47372] \frac{a \sin i}{\pi''\, P \sqrt{1 - e^2}} [e \cos \omega + \cos (v + \omega)].$$

Care must be taken to distinguish between the motions of the companion with reference to the primary, and of the primary and secondary with reference to the center of mass of the system.

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[1] For definitions of the elements used in defining the orbit of a double star, see articles by CAMPBELL and AITKEN in *Lick Observatory Bulletin*, Nos. 70 and 71, respectively.

[2] Proceedings of the Amsterdam Academy of Sciences, May 27, 1899.

[3] Sir DAVID GILL, *Mon. Not. R. A. S.*, Vol. 58, 81, 1898.

[4] *Astronomische Nachrichten*, Vol. 129, 232, 1892.

[5] *Astr. Nach.*, Vol 136, 19, 1894, equation (2).

[6] Logarithm of the factor constant for all orbits.

The value of $V$ for the companion of *Sirius* with reference to the primary becomes

$$V = \mp 5.536 \pm 11.125 \cos (v + 147^\circ\ 53'.6).$$

It follows, from AUWERS's values of the relative masses, that the radial velocities of the primary, with reference to the center of mass of the system, are given by

$$V_1 = \pm \frac{1.04}{3.24} [- 5.536 + 11.125 \cos (v + 147^\circ\ 53'.6)]$$

$$V_1 = \mp 1.777 \pm 3.571 \cos (v + 147^\circ\ 53'.6).$$

The maximum relative velocities of approach and recession occur at the two nodal points of the orbit,—that is, when the primary and companion are at the same distance from the observer,—and the extreme range of the primary's speed is the arithmetical sum of these maxima, or $5.35 + 1.79 = 7.14^{\text{km}}$.

The bright component of *Sirius* is easily observable for motion in the line of sight. Thirty-three spectrograms have been secured with the Mills spectrograph since the year 1896. Mr. KEIVEN BURNS, Carnegie Assistant in the Lick Observatory, has recently made definitive measures of all of them. The following table contains these observations, as well as those made at the Potsdam, Paris, and Yerkes observatories, which are all that are known to me. They are combined into groups, those forming each group covering only a short interval of time. The number of observations in each group is indicated in column three. The negative sign in column four indicates approach.

Neglecting the plate of 1898.07, which is very poor and stands alone, there is an unmistakable progression in the results, which we attribute to the effect of orbital motion. Whether the irregularities in the progression are real, and due to unrecognized disturbing forces in the system, or are purely accidental, cannot now be stated; but they should be examined in connection with future series of observations.

The observed progression is in the direction of algebraically decreasing velocities, and this determines that the positive value of the inclination $i$, $+44° 30'.2$, is the correct one, and that the negative sign of $i$ is to be discarded.

The observed velocity should equal the computed orbital velocity plus the velocity of the center of mass of the system. If we let $V_m$ represent the velocity of the center of mass, then each observation supplies an equation of the form

$$V_m = V_{\text{observed}} - V_1 .$$

Combining the thirty-three equations, we obtain as the velocity of the system of *Sirius*,

$$V_m = -7.4^{\text{km}} \text{ per second.}$$

The computed relative orbital velocity, $V_1$, of the primary is given in column five. The last column contains the corresponding values of $V_1 + V_m = V_1 - 7.4^{\text{km}}$.

| Observations made at | Date. | No. of Observations Combined. | Observed Velocity. | $V_1$ | $V_1 + V_m$ |
|---|---|---|---|---|---|
| Potsdam | 1888.99 | 3 | $-13.9^{\text{km}}$ | $-0.92^{\text{km}}$ | $-8.3^{\text{km}}$ |
| Potsdam | 1890.09 | 3 | —17.0 | —0.37 | —7.7 |
| Paris | 1891.17 | 1 | — 1.2 | +0.49 | —6.9 |
| Potsdam | 1891.20 | 4 | —14.9 | +0.52 | —6.8 |
| Paris | 1895.21 | 1 | — 4.1 | +5.30 | —2.1 |
| Lick | 1896.97 | 8 | — 3.2 | +4.26 | —3.1 |
| Lick | 1898.07 | 1 | [— 5.9] | +3.43 | —3.9 |
| Lick | 1898.74 | 4 | — 3.6 | +2.99 | —4.4 |
| Lick | 1899.92 | 6 | — 4.8 | +2.33 | —5.0 |
| Lick | 1901.93 | 1 | — 4.8 | +1.47 | —5.9 |
| Yerkes | 1902.06 | 10 | — 6.9 | +1.42 | —5.9 |
| Lick | 1903.07 | 9 | — 6.9 | +1.09 | —6.3 |
| Lick | 1904.95 | 2 | — 5.4 | +0.58 | —6.8 |
| Lick | 1905.12 | 2 | — 7.4 | +0.54 | —6.9 |

Assuming that GILL's parallax, ZWIERS's elements, and AUWERS's relative masses of the two stars are correct, the fourth and sixth columns should agree. We are justified, I think, in attributing the differences between the values in the columns almost entirely to errors in the observations.

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